

# **Audit**



# **Report**

OFFICE OF THE INSPECTOR GENERAL

**LESSONS LEARNED ON THE B-2 TRAINING SYSTEM**

Report No. 97-105

March 6, 1997

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**Department of Defense**

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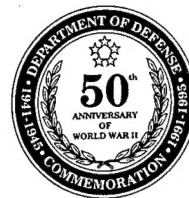
**Acronym**

LCC

Life-Cycle Cost



**INSPECTOR GENERAL**  
**DEPARTMENT OF DEFENSE**  
**400 ARMY NAVY DRIVE**  
**ARLINGTON, VIRGINIA 22202-2884**



Report No. 97-105

March 6, 1997

**MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR**  
**ACQUISITION AND TECHNOLOGY**  
**ASSISTANT SECRETARY OF THE AIR FORCE**  
**(FINANCIAL MANAGEMENT AND COMPTROLLER)**

**SUBJECT: Audit of Lessons Learned on the B-2 Training System**

## **Introduction**

We are providing this report for your information and use. Our review of the B-2 training system was conducted as part of the audit of "Requirements Planning, Development, Test and Evaluation, and Impact on Readiness of Training Simulators," Project No. 5AB-0070. We will issue a separate report on training simulators in the spring of 1997. The B-2 Bomber program experienced significant changes in its requirements that affected the acquisition of the training systems. Because of the mature stage of the B-2 program, this report provides lessons learned to improve future acquisitions of training simulators and devices instead of recommendations related to the B-2 program.

## **Audit Results**

We identified four matters that may provide lessons for future acquisitions, which are as follows:

- o The B-2 Systems Program Office bought more training devices than needed to support 21 air vehicles.
- o The Air Force did not revalidate the need for the various components of the training system as it reduced the quantity of air vehicles that it intended to buy.
- o The Air Force relied upon the air vehicle prime contractor for many training devices rather than separately contracting for the equipment.
- o The Air Force increased the cost of the B-2 training system by \$578.3 million to maintain concurrency between the training system and the three B-2 air vehicle configurations.

## **Audit Objectives**

The objective of the audit was to determine whether requirements planning, development, test and evaluation, and the potential impact on readiness of training simulators and devices were adequately considered in the acquisition process. The B-2 program was 1 of 30 programs and projects included in our

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review. Specifically, we determined whether economic analyses were considered as part of the decision process, whether test and evaluation requirements were incorporated into the Test and Evaluation Master Plan, and whether requirements were adequately supported and documented before development. In addition, we evaluated the impact of training simulators and devices on the operational readiness of the Military Departments. The final objective was to evaluate applicable management controls. Because Inspector General, DoD, Report No. 96-028, "Implementation of the DoD Management Control Program for Major Defense Acquisition Programs," November 28, 1995, adequately addresses management controls for the B-2 program, we did not review applicable management controls. See Enclosure 1 for a discussion of the audit scope and methodology. See Enclosure 2 for a summary of prior coverage related to the audit objectives.

## **Audit Background**

**The B-2 Program.** The B-2 Advanced Technology Bomber is an all-wing, two-member crew aircraft that exploits breakthroughs in low observable technology to achieve a vehicle signature that will allow penetration of current and postulated enemy defenses. In the early 1980's, the Air Force planned and budgeted to procure 132 B-2 air vehicles. In May 1990, the Secretary of Defense major aircraft review prompted a major restructure of the B-2 program. As a result of the review, the Air Force reduced the total number of B-2 air vehicles to be procured from 132 to 75. The B-2 program was affected again in January 1992, when the FY 1993 President's Budget reduced the total air vehicle procurement from 75 to 20. In 1996, the Air Force decided to upgrade the B-2 flight test vehicle, Air Vehicle 1, to operational status. Therefore, a total of 21 air vehicles will be fully operational. Also, in response to a changing threat environment, the focus of the B-2 mission shifted from a strategic nuclear role to that of a conventional, deployable bomber. The two reductions in air vehicle acquisition quantities, when combined with three block configurations for only 21 aircraft, provide the backdrop for the lessons learned for the training system acquisition.

**The B-2 Training System.** The B-2 training system is an integrated system designed to support air crew and maintenance training. To support the B-2 program, the Air Combat Command required that the B-2 training system maintain concurrency with the B-2 air vehicle configurations and be delivered before deployment of the first air vehicle. Also, the B-2 air vehicles would not be used for training purposes.

The 509th Bomb Wing conducts both air crew and maintenance training for the B-2 program at Whiteman Air Force Base, Missouri, the main location of the B-2 air vehicles. Representatives of the 509th Bomb Wing expressed overall satisfaction with the B-2 training system. The B-2 training system is composed of various air crew and maintenance training simulators and devices. Refer to Enclosure 3 for a description of each component of the B-2 training system.

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**The B-2 Training System Procurement.** In 1987, the Air Force contracted with Northrop Grumman Corporation (Northrop), the prime contractor for the B-2 air vehicle, for the training equipment needed to support 132 B-2 air vehicles. Northrop was also responsible for integration of each of the maintenance and air crew training simulators and devices into a single training system. Northrop was responsible for the contract and subsequent modifications for the development and production of the following components:

- o Cockpit Procedures Trainers,
- o the Computerized Maintenance Training System,
- o the Crew Escape Systems Maintenance Trainer,
- o the Flight Control System Maintenance Trainer,
- o the Weapons Loading Trainer,
- o the Weapon Systems Training Aids, and
- o associated courseware and support systems.

In 1985, the Air Force signed a separate \$133.5 million contract with Hughes-Link (formerly the Singer Company) to develop and produce the Weapon Systems Trainers, Mission Trainers, and associated mission generation, debriefing, and support systems. The estimated cost to completion of that contract has now increased to \$548 million, exclusive of the cost of block upgrades.

## Discussion

Table 1 shows that the cost of the B-2 training system is much greater than for other air vehicle training systems. The investment cost per student for the B-2 training system with 21 B-2 air vehicles is \$1,533,613.45.

**Table 1. Cost of Ground Based Training Systems and the Number of Air Vehicles Supported**

	<u>B-2</u>	<u>F-22</u>	<u>F-15E</u>
Number of Maintenance Trainers	45	241	8
Number of Air Crew Trainers	15	52	4
Total Cost of the Training System (millions) <sup>1</sup>	\$1,460	\$748	\$271
Number of Air Vehicles	21	438	203
<sup>1</sup> F-22 cost is a pre-production estimate			

While no air vehicle directly compares to the B-2, the cost of procuring the B-2 training system is extraordinarily expensive for the number of air vehicles supported. The Air Force may have put funds to better use if management had used options to contract for the training system and revalidated the need for the various components of the training system. The Air Force may have also reduced costs by separately contracting for the training equipment rather than relying on the prime contractor for most of the training system components. Finally, a formal process to determine the stability of the B-2 baseline configuration may have controlled costs to maintain concurrency between the air vehicle and the training system.

**Number of Training Simulators and Devices.** As exhibited in Table 2, data included in the Air Force Audit Agency Report No. 26096015, "Transition of the B-2 to the Active Air Force, 509th Bomb Wing, Whiteman Air Force Base, Missouri," April 1, 1996, suggest that the Air Force bought significantly more training devices and simulators than needed to support 21 air vehicles. The Air Force may have been able to acquire fewer training simulators and devices had it used contract options with Northrop.

**Table 2. Rate of Use Based on Contractor  
Logistics Support  
(FY 1995)**

<u>Training Simulator or Device</u>	<u>Rate of Use (percent)</u>
Weapon System Trainer	61
Mission Trainer	12
Computerized Maintenance Training System	21*
Weapon Systems Training Aid	14*
Cockpit Procedures Trainer	17*
Weapons Loading Trainer	54*

\* Rate does not include September 1995 use because data were not available at the time of audit field work.

The Air Force based the quantity of training simulators and devices required on the total number of people to be trained and the number of people to be trained per month. The number of people to be trained for the B-2 changed significantly following reductions in the number of B-2 air vehicles to be procured. When the quantity of B-2 air vehicles was 132, the number of air crew members to be trained was 344 and the number of enlisted personnel was 4,500. For 21 B-2 air vehicles, the number of persons to be trained is 52 air crew members and 900 enlisted personnel. The numbers are for support of 132 air vehicles and 21 air vehicles, respectively, and do not represent replacement training. The number of people to be trained per month was derived from the number of air vehicles to be delivered per month. When the Air Force reduced the total number of B-2 air vehicles to be acquired from 132 to 75, the rate of air vehicles delivered per month remained the same. Consequently, the Air Force determined that it would need to train the same number of people per month; that is, the initial training would occur over fewer

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total months, but the Air Force would train the same number of students per month. Therefore, the Air Force assumed that the quantity of training simulators and devices required to support the B-2 program would remain unchanged.

By the time the Air Force reduced the quantity of B-2 air vehicles to be acquired to 20, the training devices to support 132 air vehicles had already been produced. The Air Force therefore did not have the flexibility to reduce the number of training components acquired to match the change in the planned quantity of air vehicles.

The Federal Acquisition Regulation subpart 17.2, "Options," defines option as "a unilateral right in a contract by which, for a specified time, the Government may elect to purchase additional supplies or services called for by the contract . . . ." The Federal Acquisition Regulation subpart 17.2 allows the use of options in contracts when the use of options is in the best interest of the Government and when the option does not represent firm requirements for which funds are available. Because only 11 air vehicles were on contract when the Air Force contracted with Northrop for all the equipment needed to support 132 air vehicles, the Air Force had a firm requirement to support only 11 air vehicles. By contracting for an initial quantity of training simulators and devices with options for additional quantities, the Air Force would have had the flexibility to buy fewer training simulators and devices initially, and then increase the amount in increments when the quantity of B-2 air vehicles to be acquired changed. For example, the use of options on the contract with Hughes-Link allowed the Air Force to acquire only three of the eight planned Weapons System Trainers.

**Cost-Effectiveness of the Training Media.** The Air Force spent about \$578.3 million to upgrade the B-2 training system to maintain concurrency with an evolving air vehicle. Considering the decrease in the number of personnel to be trained, the decision to upgrade all the training devices might not have been the most cost-effective solution for B-2 training. The Air Force may have been able to make better use of funds had it reevaluated the training media mix before committing funds to upgrading the training devices.

**Selecting Training Media.** The Air Force applied Instructional Systems Development procedures to both air crew and maintenance training to identify design requirements and to develop and update lessons for training systems. The Instructional Systems Development process is a framework to identify training requirements for the design and development of materials and devices. The process provides a systematic program for development of the entire training system and is used to evaluate cost-effectiveness of alternate approaches. Part of the Instructional Systems Development process involves the selection of media. Media are the instruments or materials used to communicate information. Examples of media range from classroom instruction to training devices and high fidelity simulators. Appropriate media selection ensures that the information to be learned is presented in the most effective and efficient means possible.



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The training media for the B-2 training system are composed of courseware and training simulators and devices. The Air Force selected the final training media based on the Training Media Plan prepared by Northrop in 1984. The Training Media Plan analyzed the cost-effectiveness of the candidate training media using mathematical models based on the life-cycle cost (LCC) of the training system and the number of personnel to be trained. The number of personnel to be trained was derived from the original 132 B-2 air vehicles that were to be procured.

**Effects of Changing Requirements.** If the basis of the training media changes, so does the cost-effectiveness. For example, the operating costs of traditional media such as classrooms, on-the-job training, and self-study are highly dependent on the number of students, or what the Instructional Systems Development program calls the "trained personnel requirement." If the number of personnel to be trained decreases substantially, the total LCC of traditional media would also decrease. The change in the LCC can reasonably be expected to have an effect on the relative LCC of the elements of the training system, which were used in evaluating the cost-effectiveness of the training media.

In contrast, a decrease in the number of personnel to be trained would not significantly affect the LCC of the training simulators and devices because the fixed cost of procurement represents the most significant portion of the LCC. Nevertheless, without a requirement to fund substantial upgrades for the simulators and devices, the cost-effectiveness of the training system would remain unchanged because the fixed investment in training devices and simulators had already been made.

The cost-effectiveness may change, however, when the training devices and simulators require costly modifications. Then, the cost of the modifications increases the LCC for the training simulators and devices. The revised cost must then be compared with the revised LCC of the traditional media to determine whether the current media mix still represents the most cost-effective training system.

**Training Media for the B-2 Training System.** The cost-effectiveness of the B-2 training system was affected by both a decrease in the number of personnel to be trained and an increase in LCC as a result of the cost of modifications to the B-2 air vehicle baseline. The impact of the change on system cost-effectiveness should have been determined by analysis. At the time that the Air Force made decisions concerning block upgrades, the estimated cost of the simulators and devices on which the media selection had been made had changed. For example, the contract budget base for the Hughes-Link Engineering and Manufacturing Development contract was originally \$133.5 million. The current contract budget base, incorporating approved program changes, is \$273 million; however, the September 1996 estimate at completion of the final Engineering and Manufacturing Development contract is \$548 million. The increase in the contract budget base is 105 percent and the current estimate of the final cost is an increase of 311 percent more than the original estimate.



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Whether the increases to the cost of the training system, either separately or when combined with the reduction in the LCC of the traditional media, would have changed the cost-effectiveness of the media cannot be known with certainty. Nevertheless, cost changes of that magnitude were likely to reduce the cost-effectiveness of device-based training. By reevaluating the cost-effectiveness of the B-2 training system when the B-2 program was reduced, the Air Force may have avoided unnecessary costs to upgrade and maintain existing training simulators and devices. Instead, the Air Force might have adopted alternative forms of training that were more cost-effective.

**Breakout Analysis.** The Air Force contracted directly with Hughes-Link for the Weapon Systems Trainer and the Mission Trainer and with Northrop for the remainder of the training system, including the Computerized Maintenance Training System, Weapon Systems Training Aid, Cockpit Procedures Trainers, and Weapons Loading Trainer. The Air Force spent 74 percent of the Northrop contract, valued at \$414 million, for the training system with only three subcontractors.

Given the high level of subcontractor support, the Air Force may have put funds to better use by separately contracting for components directly with the manufacturer or supplier and furnishing them to Northrop as Government-furnished material. However, the Air Force did not perform a breakout analysis when it contracted for the training simulators and devices.

**Cost to Maintain Concurrency.** The user of the B-2 training system established a primary requirement to develop and deliver a concurrent training system before deployment of the first operational B-2 air vehicle and to modify the equipment to the latest block configuration before the delivery of the first air vehicle from each new block. Concurrency involves having the configuration of the training devices mirror the aircraft configuration. The decision to require that the training system be delivered before the air vehicle and at the same time be concurrent with an unbuilt and undelivered air vehicle was a very expensive decision given the constantly changing aircraft configuration, that is, the decision to build only 21 B-2 air vehicles in three different initial configurations.

The B-2 program's air vehicle delivery strategy is separated into three increments of increasing hardware and software functional capability. The increments were referred to as Block 10, Block 20, and Block 30 air vehicles. In-line production changes to aircraft being delivered for operational use require the Air Force to maintain multiple aircraft and air crew training device configurations until system maturity is reached. Therefore, each of the air vehicle configurations requires air crew training devices with similar functional training capability for air crews to exploit the increasing capabilities of the aircraft.

To successfully accomplish concurrent development of the air vehicle and the training system, the air vehicle baseline should be relatively stable. The baseline for the B-2 air vehicle, however, was not stable. For example, the Air Force released three major Operational Flight Program sets before the delivery of the first air vehicle. Such updates required time to integrate into the

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training system and also required some redesign of interface software. Ultimately, maintaining concurrency in the development of the air vehicle and the training system resulted in a cost of at least \$578.3 million.

Representatives of the B-2 Training Team indicated that the number of months between the freeze date and the delivery date of the B-2 air vehicle was decreasing. Freeze date refers to the date that the design for the training simulation or device is fixed. The date is based on the assumption that the configuration for a given air vehicle block is known with sufficient certainty to design a training system to mirror that configuration. Achieving the requirement of delivery of a training system before the first air vehicle of each block required freezing the design up to 24 months before the required delivery date for the training system. Specifically, Northrop incorporated air vehicle changes to the B-2 training system after the freeze date to deliver a product that was more current. The Air Force may have benefited by implementing a systematic process to identify the best time to freeze the air vehicle baseline to develop the training system. A basis to develop such a process could be the process used by the Air Force to certify system readiness for dedicated operational test and evaluation. The test and evaluation process provides a structured mechanism for identifying and reducing risks associated with transitioning from developmental test and evaluation to dedicated operational test and evaluation. A standard framework is detailed in various templates that contain historical information and practical advice about how to reduce or eliminate risk. A process based on templates may be applicable in determining when the B-2 air vehicle baseline is stable enough to successfully develop training simulators and devices.

## **Cost Performance Reports**

Cost performance reports required by the contracts made with Northrop did not provide sufficient detail to assist the Government in managing the B-2 training system acquisition. According to the "Cost/Schedule Control Systems Criteria Joint Implementation Guide," October 1, 1987, the contractor normally provides cost data to the Government at the third level of the contract work breakdown structure or higher. The Government only required Northrop to report the costs for the B-2 training system at Level 2. That decision meant that the training system cost and price information in the monthly "Cost Performance Reports" and quarterly "Contract Funds Status Reports" for the B-2 training system was reported only as a single line item.

For the B-2 cost performance reports, Level 1 was the overall program; Level 2 included 9 categories, for example, Test and Evaluation, Air Vehicle, and Training; and Level 3 included categories such as Instructional Systems Development, Academic Training Materials, and Training Equipment. The report did not follow the contract work breakdown structure detail that included 9 Level 3 categories that were further enumerated into 21 Level 4 categories. The contract work breakdown structure at Level 4 included a contract work breakdown structure designator for each distinct device developed for the B-2

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training system. Northrop collected information as contract work breakdown structure levels below Level 2, but was not contractually obligated to provide the data to the Government.

Because the contract did not require reporting of costs and funds management below Level 2, the B-2 Systems Program Office was unable to provide definitive cost data about the costs for the elements of the Northrop B-2 training system including the cost of each type of training device and the cost of the block upgrades. Cost information on the cost of the various devices and the cost to upgrade the devices was essential information for effective cost management.

For the Hughes-Link contract, the Air Force also required Level 2 reporting; however, the impact of the requirement was not the same for the training system. Level 2 for the Northrop B-2 contract showed the cost for the entire B-2 training system. Level 2 for Northrop was equivalent to Level 1 for the Hughes-Link contract. Level 2 for the Hughes-Link contract included detail on the cost of the Weapon Systems Trainer and Mission Trainer. Level 2 for Hughes-Link provided significantly more cost information for managing the training system acquisition and was equivalent to Level 3 data for the Northrop contract. Even so, those reports were less than clear on the reasons for increases in the contract budget base and the approved formal reprogramming adjustments. Also, a representative of the Air Force Cost Analysis Agency indicated that failure to report cost information at the appropriate level may impact the accuracy of historical cost information available for future cost estimating. If program offices do not appropriately report cost information, cost analysts will not have the most accurate data on which to base future cost estimates.

## **Management Comments and Audit Response**

We provided a draft of this report on November 14, 1996. Although no comments were required, the Office of the Under Secretary of Defense for Acquisition and Technology (the Under Secretary) responded to our report. The full text of the comments is in Enclosure 4.

**Management Comments.** The Deputy Director, Air Warfare Strategic and Tactical Systems, stated that the additional cost of \$578.3 million to maintain concurrency with three block configurations was justified because of the need to accelerate operational use of the B-2 air vehicle. Furthermore, the Deputy Director indicated that comparing the cost of the B-2 training system to the less costly F-22 and F-15E training systems did not recognize significant differences in the training concepts and capabilities. In addition, separately contracting for components of the B-2 training system with the equipment manufacturer or supplier, instead of with Northrop, would have increased the risk to the Government for system integration problems and cost, as well as increasing the risk to security. The Deputy Director made suggestions to improve the clarity and accuracy of the report.

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**Audit Response.** The determination of whether or not developing 3 block configurations was necessary to accelerate operational use of the 21 B-2 air vehicles was outside the scope of our audit. Nevertheless, the decision resulted in the need to maintain concurrency between the three B-2 air vehicle configurations and the training system. That need to maintain concurrency between the air vehicle configurations and the training system increased the cost of the training system by about \$27.5 million per air vehicle. Furthermore, we acknowledge that differences in training concepts and capabilities of the training systems make it difficult to compare training system costs. However, when considered from the perspective of the number of operational air vehicles, the B-2 training system cost \$69.5 million per air vehicle, as compared to \$1.7 million for the F-22 and \$1.3 million for the F-15E. We continue to question whether differences in training concepts and capabilities justify the cost. In addition, the Services use breakout analyses to evaluate risks and related costs and benefits of separately contracting for system components with equipment manufacturers and suppliers. If the Air Force had conducted such a breakout analysis, it might have had a firm basis for its decision to contract only with Northrop and Hughes-Link.

For additional information on this report, please contact Mr. Raymond A. Spencer, Audit Program Director, at (703) 604-9071 (DSN 664-9071) or Mr. David F. Vincent, Audit Project Manager, at (703) 604-9058 (DSN 664-9058). Enclosure 5 lists the distribution of this report. The audit team members are listed inside the back cover.

*David K. Steensma*

David K. Steensma  
Deputy Assistant Inspector General  
for Auditing

Enclosures

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## **Audit Process**

### **Scope and Methodology**

We reviewed documentation relating to the acquisition of the B-2 training system dated from November 1981 through July 1996 to accomplish our audit objectives. We reviewed the B-2 training system, estimated to cost \$1,460 million, and related cost data, contract information, planning documentation, and system requirements. We also interviewed key personnel directly involved with the program. Because Inspector General, DoD, Report No. 96-028, "Implementation of the DoD Management Control Program for Major Defense Acquisition Programs," November 28, 1995, adequately addressed management controls for the B-2 program, we did not review the management control program as it relates to our objectives.

### **Audit Period and Standards**

We conducted this economy and efficiency audit from November 1995 through September 1996 in accordance with auditing standards issued by the Comptroller General of the United States, as implemented by the Inspector General, DoD. We did not use computer-processed data or statistical sampling procedures for this audit.

### **Organizations and Individuals Visited or Contacted**

We visited or contacted individuals and organizations within the DoD and the Northrop Grumman Corporation. Further details are available on request.

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## Summary of Prior Audits and Other Reviews

### Inspector General, DoD

Inspector General, DoD, Report No. 96-028, "Implementation of the DoD Management Control Program for Major Defense Acquisition Programs," November 28, 1995, states that the acquisition community had not effectively integrated DoD Management Control Program requirements into its management assessment and reporting processes. With respect to the B-2, the reporting manager at the B-2 Program Office stated that management control objectives and techniques in DoD Instruction 5000.2 were not being identified and documented as part of the management control evaluation. The report made no recommendations specifically to the B-2 Program Office.

### Air Force

**Transition of the B-2 to the Active Force.** The Air Force Audit Agency issued two audit reports related to the B-2 training system.

- o The Air Force Audit Agency Installation Report No. 26096015, "Transition of the B-2 to the Active Air Force, 509th Bomb Wing, Whiteman Air Force Base, Missouri," April 1, 1996. The report states that actual and forecasted use of air crew and maintenance simulators did not justify the level of contract logistics support. In addition, forecasts indicated that expected use for future years did not justify planned contract logistics support for those years. The Commander, 509th Bomb Wing, concurred with the finding, but indicated that the level of contractor support for B-2 training simulators was not the responsibility of the 509th Bomb Wing. Therefore, the information contained in the Air Force report will be forwarded to the audit control point for use in evaluating simulator forecasting and contracting procedures at headquarters, Air Combat Command, and the System Program Office, Wright-Patterson Air Force Base, Ohio.

- o The Air Force Audit Agency Installation Report No. 44596035, "Management of the B-2 Transition to the Active Force, Aeronautical Systems Command, Wright-Patterson Air Force Base, Ohio," March 15, 1996. The report states that the appropriateness of contractor logistics support availability levels could not be determined because Air Combat Command personnel had not developed long range training schedules for maintenance training devices and air crew trainers and simulators. Therefore, the issue was provided to the audit control point for possible inclusion in the overall Air Force Evaluation.



## Summary of Prior Audits and Other Reviews

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**Management of the B-2 Training System.** The Air Force Audit Agency Report No. 44594024, "Management Review of B-2 Trainers and Simulators, Aeronautical Systems Command, Wright-Patterson Air Force Base, Ohio," February 14, 1994, states the following:

- o Configuration status accounting systems did not provide data consistent with the configuration management plans and contract data requirements lists.

- o Program office personnel did not document consideration assessments for late data deliveries, and personnel did not always accurately apply withholds for trainers delivered with open discrepancy reports.

- o The financial manager did not reconcile cost performance report summary information to detailed variance explanations.

Management actions taken or planned were responsive to the problems identified.

## Components of the B-2 Training System

Type of Device	Description
<b>Maintenance Training</b>	
Computerized Maintenance Training System (CMTS)	Provides three-dimensional system operation and fault isolation training on hydraulics/landing gear, fuel, propulsion, integrated avionics, electrical/lighting, armament, environmental conditioning, and flight control system. The trainers incorporate simulated hardware, simulation models, and courseware.
Weapon Systems Training Aid (WSTA)	A single-student, videodisc-based device designed for initial training. The WSTA provides two-dimensional system operation and fault isolation maintenance training on the same systems as the CMTS.
Weapons Loading Trainer (WLT)	A simulated aircraft structure that consists of a computational system, an instructor station, and a simulator flight crew station. The trainer is used for training and certifying Aircraft Armament Systems Specialists/Technicians to perform on-aircraft weapons loading and unloading tasks.
Crew Escape Systems Maintenance Trainer (CESMT)	Replicates both the internal and external characteristics of the flight crew compartment. The trainer is used to train maintenance personnel in safe arming and disarming of pyrotechnic devices, inspection and testing of related seat components, removal and installation of seats, inspection and on-aircraft maintenance of related seat components, and safe removal and installation of the escape hatch assemblies. The trainer is also used as an egress safety familiarization trainer.
Flight Control Systems Maintenance Trainer (FCSMT)	A simulated flight crew station frame with an integrated rudder pedal assembly, control stick assembly, throttle assemblies, and computational system. Used to train the skills associated with the fault isolation, removal/replacement, rigging, and functional check-out of the flight control system and throttle system assemblies within the flight crew station.

## Components of the B-2 Training System

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Type of Device	Description
<b>Air Crew Training</b>	
Weapon Systems Trainer (WST)	A high fidelity full-scale mockup of the B-2 cockpit with all systems completely active and integrated. The WST provides air crew training in a realistic combat environment with sufficient complexity to develop necessary air crew coordination required during nuclear, conventional, and training operations.
Mission Trainer (MT)	A high fidelity, full-scale mockup, which contains all instruments, indicators, displays, associated lights, and controls of the right side of the B-2 Crew Station. The MT supports Mission Commander qualification training.
Cockpit Procedures Trainer (CPT)	Provides drill and practice in procedural tasks, decisionmaking, and problem solving for air crew members. Flight crew procedures training is provided on the CPT system through the use of simulation models, courseware, and simulated hardware.

# Office of the Under Secretary of Defense Comments



ACQUISITION AND  
TECHNOLOGY

## OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON  
WASHINGTON DC 20301-3000



21 JAN 1997

MEMORANDUM FOR DIRECTOR ACQUISITION MANAGEMENT, OFFICE OF  
THE INSPECTOR GENERAL

FROM: DEPUTY DIRECTOR AIR WARFARE  
Prepared by Col C. Nelson/AW/53165/15 Jan 97

SUBJECT: Draft Audit Report, "Lessons Learned on the B-2 Training  
System (DoD IG Project No 5AB-0070.01) Nov 14, 1996

The draft report identifies four matters as audit results that provide lessons for future acquisitions. Two other matters warrant up-front presentation, as well as being addressed in later discussion. First, the DoD reduced the B-2 fleet from 132 to 75 in 1990 followed by the President's decision in 1992 to stop production at 20 B-2s. The President's decision came after all training devices were on contract and well into production to be delivered in 1993, before the first operational aircraft. The lesson for program directors may be to consider acquisition strategies that accommodate quantity and schedule changes, even beyond the expected range.

Second, the B-2 program delivered operations and maintenance trainers prior to delivery of the first operational aircraft that provide robust initial and continuation training capabilities. This high-fidelity training system reduces the use of aircraft for ground and airborne training, lowering associated cost and risk, a strategy essential for prudent management and readiness of a small, high-value aircraft fleet.

The enclosed response provides comments and technical corrections. We appreciate the opportunity to review the draft report.

Ronald Mutzelburg  
Deputy Director Air Warfare  
Strategic and Tactical Systems

Enclosure



## Office of the Under Secretary of Defense Comments

Final Report  
Reference

DoD IG Draft Audit Report  
(Project No. 5AB-0070.01)  
"Lessons Learned on the B-2 Training System"

"Audit Results": "(4) The Air Force increased the cost of the B-2 training system by \$578.3 million to maintain concurrency between the training system and the three B-2 air vehicle configurations." (pg 1)

Comment: The Air Force did not arbitrarily increase the cost of the training system. The decision to accelerate fielding of the B-2 by developing it through three block configurations considered all costs, including the required modifications to the training system. Fidelity of the training system with the weapon system is an operational requirement driven by safety and combat readiness. A more accurate statement is, "The cost of developing the B-2 through three configurations to accelerate operational use, included \$578.3 million to maintain required concurrency between the training system and the B-2 air vehicle configurations."

"The B-2 Training System Procurement": This paragraph states that as part of a 1987 contract, Northrop Grumman Corporation was responsible for the Flight Control System Maintenance Trainer. (pg 3)

Comment: The Flight Control System Maintenance Trainer was not part of the 1987 training system contract. It was placed on contract in 1996 following extensive cost-benefit analysis and requirements validation.

"Discussion": Table 1 and the associated paragraph state the cost of the B-2 training system is much greater than for other air vehicle training systems and provides a cost per student for the B-2 as \$1,533,613.45. The report goes on to state that while no other air vehicle directly compares with the B-2, the cost of procuring the B-2 training system appears extraordinarily expensive for the number of air vehicles supported. (pg 3/4)

Comment: The report provides a cost per student on the B-2, but not for the other aircraft, nor figures on the number of students for any of the systems. It would be useful for the table to display the number of students supported for each air vehicle. Raw figures comparing cost per aircraft or student imply an apples-to-apples comparison and do not provide insight into significant differences in the weapon training concept and capabilities of the training systems. For example, the B-2

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Weapon System Trainer currently provides 20 hours per month of training to each mission qualified crew (who fly only 9 hours per month in a B-2 aircraft) and supports highly complex tasks, such as certifying aircrews for terrain following/terrain avoidance in the Weapon System Trainer. The B-2 training system is also capable of certifying weapons load crews in the Weapons Loading Trainers, meeting the demanding requirements of nuclear weapons certification. The table should also caveat the F-22 costs as pre-production estimates.

revised

"Breakout Analysis": The Air Force contracted directly with Hughes-Link for the Weapon Systems Trainer and the Mission Trainer and with Northrop for the remainder of the training system. Further, the Air Force may have put funds to better use by separately contracting for components directly with the manufacturer or supplier and furnishing them to Northrop as government-furnished material. (pg 8)

Comment: The decision to contract with Northrop for the training system (except the trainers contracted to Hughes-Link) considered risk, program management, and security as well as cost. Northrop, as prime contractor, was responsible for providing a fully-integrated training system under the fixed-price contract. Breaking out the training system would require additional program office people to manage the effort and would have increased the risk to the government for system integration problems and costs. Program security classification was also a factor that favored limiting the number of contractors and facilities given access to the program.

"Cost to Maintain Concurrency": The last paragraph (line 4) reads, "...the Air Force released three major Operational Flight Plans before delivery..." (pg 8)

Comment: The correct term is "Operational Flight Program sets."

revised



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